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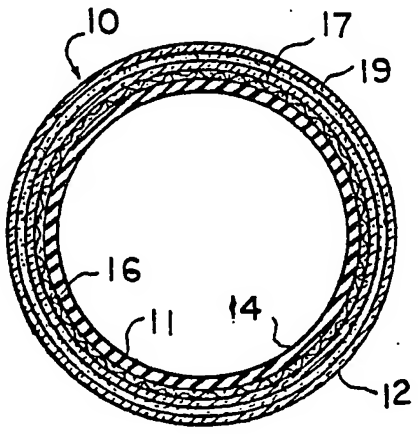
(54) Title: LEAK DETECTION FOR LIQUID HOSES



(57) Abstract

A film (17) of color change material is formed on the outer surface (12) of a liquid-carrying hose (10) to provide a leak detection function. Should pressurized liquid leak through a crack in the hose (10) wall (11) (or at a loosely clamped end of the hose (10)) the detection material will react with the escaping liquid to provide a visible indication of leaking condition. One example of usage of the invention is on coolant circulation hoses (10) used in internal combustion engines; another usage is in a hydraulic system.

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LEAK DETECTION FOR LIQUID HOSES

Background of the Invention

This invention relates to liquid hoses, e.g. hoses used for circulating liquid coolants in internal combustion engines. A principal aim of the invention is to incorporate into the hose a leak detector film that exhibits a color change in the presence of a leaking liquid condition.

Historically the coolant circulation hoses in internal combustion engines have a black or dark gray outer surface. Should a leak develop along the hose or at clamped ends of the hose it becomes difficult to visually ascertain the leaking condition. The leaking liquid will appear merely at a darkened zone on the hose outer surface, such that an untrained person may mistakenly believe the darkened area is an oil spot or merely a localized color discontinuity in the hose coloration.

Sometimes slow leaks can develop in the coolant-circulation hose. Pressurized liquid can seep through small cracks in the hose surface or around semi-loose hose clamps; when the engine is shut down the coolant pressure is reduced whereby the small cracks close up, so that the hose structure appears to be intact and leak-free.

The present invention contemplates a leak detection film extending along the outer surface of a pressure-resistance hose, whereby liquid escaping through a crack in the hose reacts with the leak detection film to produce a visible color change. A person viewing the hose after the hose has been de-pressurized can observe the changed color, and thus determine that the hose has a crack sufficient to produce a leak when the liquid is in

a pressurized condition.

In a preferred form of the invention the outer surface of the hose is white, or some relatively light color, e.g. yellow or light blue. The leak detection film will be a relatively thin film on the hose outer surface, whereby the film is normally essentially transparent or translucent, i.e. substantially visible. Should a leak develop in the hose wall or at the hose end surface the leaking liquid will chemically react with the leak detection film to produce a reaction product having a contrasting coloration to the light coloration of the hose outer surface.

The leak detection film can be chosen from among a number of substances, which possess the quality of changing colors when caused to chemically react with another liquid, e.g. a coolant or a coolant mixed with water to circulate in an automotive radiator system.

A great number of chemicals was tested to determine their respective suitability for the intended purpose of the invention.

It was found that the following chemicals produced the desired results, according to the invention:

	Name of Chemical	Original Color	Changing Into	Approx.pH Range
1.	Phenolphthalein	: clear	: red	: 8.2-10.0
2.	Curcumin	: yellow	: red	: 7.4-8.6
3.	Thymolphthalein	: clear	: blue	: 9.4-10.6
4.	Cresolphthalein	: clear	: red	: 8.2-9.8
5.	Phenolsulfonephthalein	: clear	: red	: 6.6-8.0
6.	Cresolsulfonephthalein (Metacresol Purple)	: yellowish/ brown	: purple	: 7.4-9.0

7.	Cresolsulfonephthalein (Cresol Red)	: yellow	: blue	: 7.0-8.8
8.	Bromothymol Blue	: yellow	: blue	: 6.0-7.6

The above-named chemicals, numbered 1 through 6, directly change colors, as indicated, when brought in contact with e.g. a coolant or antifreeze with a pH of 10. The coolant and antifreeze, when mixed with water has a pH of 9. The chemicals numbered 7 and 8 have a coloration reaction when changed into acid form, i.e. mixed with hydrochloric acid.

THE DRAWINGS

Fig. 1 is a fragmentary side elevational view of a liquid circulation hose construction having a leak detection film on its outer surface, according to the present invention.

Fig. 2 is a sectional view taken on line 2-2 in Fig. 1.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

The drawings fragmentarily show a pressure-resistant hose 10 formed primarily of an elastomeric material having flexibility and resilience for containment of the internal liquid pressure. The hose is shown as a multi-ply tubular wall 11 having an outer surface 12 and an inner surface 14. A wire cloth reinforcement 16 can be arranged between the inner and outer plies of the tubular wall. At least the outer ply of the tubular wall has a white or light coloration.

As shown in Fig. 2, the outer surface of wall 11 has a film 17 of material thereon. A second protective film 19 is provided

over film 17. Film 17 is comprised of solid particulates of a color change material adhered to surface 12 of the tubular wall by a coating of a transparent adhesive. Film 19 is a transparent coating or outer band and applied to the exposed surface formed by the color change material. Film 19 may be formed of a relatively thin colorless polythylene tape material wound helically on the tubular wall and heated to encapsulate the color change material 17. The solid particulate color change material in film 17 may e.g. be any of the above-named chemicals or other material that undergoes a color change when brought into physical contact with the pressurized liquid, such as coolants or hydraulic fluids, leaking from within the hose structure.

As the pressurized liquid comes into contact with the color changing material the latter undergoes a color change, e.g. from an essentially colorless or (pale yellow) condition to a red/blue/purple condition that contrasts sharply with the light coloration on other areas of outer surface 12 where there is no escaping the location of the leak for making temporary repairs, or replacement of the hose.

Protective film 19 serves to shield the color change material from the external atmosphere during normal operational periods, whereby the color change material is prevented from being dislodged from the hose surface, e.g. by vibration, or from being contaminated by external direct accumulations. Should a leak develop the protective film 19 tends to retain the color change material on tube surface 12, thereby preserving the color change for later observation by the motorist mechanic.

In applying film 17 to the tube outer surface 12 the tube

may first be sprayed or brushed with a thin film or contact adhesive. The finely divided (powdered) color change material may then be sprayed as a thin essentially transparent film on the tacky tube surface 12. The color change material will have a relatively small particle size so as to provide a thin coating that does not appreciably obscure the coloration of the tube outer surface. Film 19 may be a thin transparent tape wound helically on the coated tube surface 12. As an alternative, film 19 could be formed by spraying or rolling the transparent protective materialy on the coated tube surface.

The invention was devised to provide a visible leak detection mechanism for hoses used to circulate liquid coolants within internal combustion engines, e.g. in automobiles or trucks. Such coolants commonly comprise ethylene glycol in a dilute water solution (or emulsion). A hose coating for example of phenolphthalein will chemically react with the ethylene glycol with additives to produce a visible color change on the tube outer surface, i.e. from an essentially colorless condition to a red coloration or stain that contrasts with the light coloration on the hose surfaces not contacted by the escaping liquid.

Preferably the entire outer surface of the hose (including the hose end faces) is coated with the color change material for example, phenolphthalein, which is an acid-base indicator used in chemical analyses. The protective film 19 will completely encapsulate the color change material, including material on the hose end faces. Spraying may be used to apply film 19 to the material on the hose faces.

However, it may be possible to apply, e.g. by means of a spray can, the color changing material after the user suspects that a leak in the hose has occurred, in which case the protective film 19 is eliminated.

It is believed that the invention could be applied to other types of hoses carrying other types of liquid where leakage is a problem, e.g. gasoline hoses, liquid propane lines or hydraulic lines. The color change material would have to be selected with regard to its capability for undergoing a color change when brought into contact with the specific liquid being carried by the hose.

CLAIMS

I claim:

1. A hose (10) construction for a pressurized liquid, comprising a flexible tubular wall (11) having an inner surface (14) and an outer surface (12), said wall (11) being formed by a flexible resilient material subject to cracking over time, with consequent escape of the pressurized liquid; a film (17) of a color change material on the outer surface (12) of the tubular wall (11), said color change material being capable of chemically changing color when it is brought into physical contact with the aforementioned pressurized liquid.

2. The hose (10) construction of claim 1, wherein a protective film (19) of transparent material overlying said color change material (17) is applied, so that the color change material (17) is physically isolated from the external atmosphere while being visible through the transparent protective film (17).

3. The hose (10) construction of claim 1, wherein the outer surface (12) of the tubular wall (11) is relatively light opaque color, and the film (17) of color change material is sufficiently thin that the opaque coloring on the outer surface (12) of the tubular wall (11) determines the apparent coloration prior to chemical color change in the color change material.

4. The hose (10) construction of claim 3, wherein said color change material (17) is adhered to the outer surface (12) of the tubular wall (11) by means of a transparent adhesive.

5. The hose (10) construction of claim 3, wherein the tubular wall (11) constitutes a coolant hose (10) in an internal combustion engine, and the pressurized liquid is an anti-freeze solution containing ethylene glycol.

6. The hose (10) construction of claim 3, wherein the tubular wall (11) constitutes a hose (10) for a pressurized liquid in a hydraulic system.

7. The hose (10) construction of claim 1, wherein the color changing material comprises Phenolphthalein.

8. The hose (10) construction of claim 1, wherein the color changing material comprises Curcumin.

9. The hose (10) construction of claim 1, wherein the color changing material comprises Thymolphthalein.

10. The hose (10) construction of claim 1, wherein the color changing material comprises Cresolphthalein.

11. The hose (10) construction of claim 1, wherein the color

changing material comprises phenolsulfanephthalein.

12. The hose (10) construction of claim 1, wherein the color changing material comprises Cresolsulfanephthalein (Metacresol Purple).

13. The hose (10) construction of claim 1, wherein the color changing material comprises Cresolsulfanephthalein (Cresol Red).

14. The hose (10) construction of claim 1, wherein the color changing material comprises Bromothymol Blue.

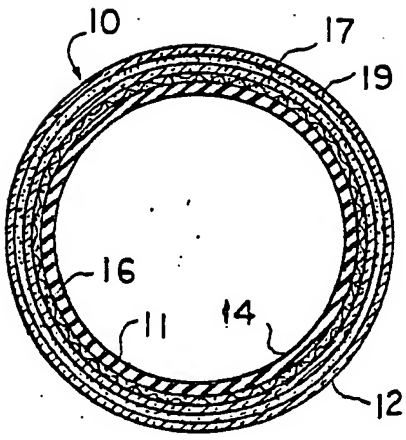

FIG. 2

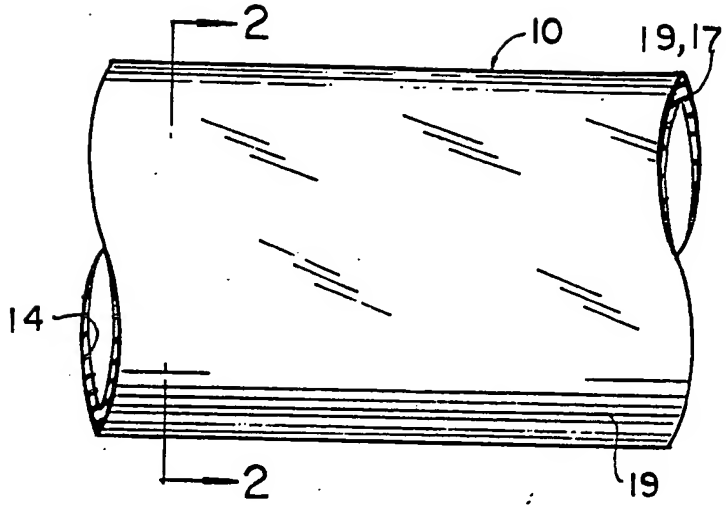

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/06863

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :F16L 55/00
US CL :138/104

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 138/36, 111, 148; 73/40.7, 49.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	DE, A, 2,854,016 (Ropertz) 03 July 1980, see entire document.	1, 2 ------ 3-6
Y	DE, A, 2,552,508 (Dittrich) 26 May 1977, see entire document.	3, 5, 6
X ---- Y	US, A, 4,244,693 (Guon) 13 January 1981, see entire document.	1, 2, 6, 7, 9, 14 ---------- 3-5, 8, 10-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search 05 OCTOBER 1993	Date of mailing of the international search report 21 OCT 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer Sheila Vesey for JAMES E. BRYANT III Telephone No. (703) 308-1280

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/06863

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/06863

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

The claims are drawn to the following patentably distinct species of the invention, the species of the color changing material being:
I. Phenolphthalein;
II. Curcumin;
III. Thymolphthalein;
IV. Cresolphtalein;
V. Cresolphthalein;
VI. phenolsulfanepthalein;
VII. Cresolsulfanephthalein (Metacresol Purple);
VIII. Cresolsulfanephalein (Cresol Red); and
IX. Bromothymol Blue.